REMARKS/ARGUMENTS

The claims are 1-7 with claims 8-17 having been withdrawn from consideration as directed to a non-elected invention/species.

Claims 1-3, 5 and 6 were rejected under 35 U.S.C. §102 (b) as being anticipated by *Crozier et al. U.S. Patent No. 5,818,319*. Claims 4 and 7 were rejected under 35 U.S.C. 103(a) as being unpatentable over *Crozier et al.* in view of *Leue et al. U.S. Patent No. 4,680,547*.

Essentially, the Examiner's position was that (1) *Crozier et al.* discloses the method of designing a magnetic resonance imaging magnet recited in the claims except for the magnetic field having a design peak-to-peak magnetic field inhomogeneity of less than 10 parts per million with an imaging volume between 20 to 50 cm in diameter, and a magnetic field strength of 0.5-3.0 Tesla, (2) that *Leue et al.* suggests that it would have been desirable to have a magnetic field with a field strength of 1.5 Tesla and a design peak-to-peak magnetic field inhomogeneity of approximately 2 parts per million in an imaging volume of at least 5 cm in diameter from an operational standpoint in an MRI device and to control the spatial linearity, and (3) that it

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would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified the method of *Crozier et al.* by using the magnetic field strength and design peak-to-peak magnetic field inhomogeneity taught by *Leue et al.* to positively achieve an operational MRI and control the spatial linearity. With regard to the imaging volume being between 20 to 50 cm in diameter the Examiner considered this feature to be within the skill of the art.

This rejection is respectfully traversed.

As set forth in claim 1, Applicants' invention provides a method of designing a magnetic resonance imaging magnet in which one or more correction coils are used to reduce the lower order harmonics generated by the magnet to improve homogeneity of the magnetic field at selected volumes around the magnet. The correction coils are considered to be part of the magnetic coil design in order to reduce the lower order harmonics of the entire system, that includes not only the magnet coils but also the correction coils.

In contrast to prior processes in which the design field homogeneity is received by optimizing the geometry of only the

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main and bucking coils, and correction coils are used only in a separate process for correcting the field errors that represent mainly lower order harmonics, the advantage of Applicants' process is that it prevents the homogeneity at the small volume from being sacrificed by meeting the requirement at a large volume and avoids excessive iterations of design cycles and more costly output results that have more coil turns and/or more numbers of coils with positively or negative currents.

None of the cited references to *Crozier et al.* or *Leue et al.* discloses a process of designing a magnetic resonance imaging magnet in which the design of the MRI magnet and the correction coils are included together in the design loop. *Crozier et al.* discloses a method of designing an MRI magnet, or a shim magnet, or a gradient magnet which involves the use of a simulated annealing procedure in which weighted spherical harmonics are included in the error function (see col. 4, lines 21-23 and lines 41-49, col. 6, lines 23-27 and FIGS. 3 and 4). By iteratively reducing the error function (in most cases the spherical harmonics), a good magnet design can be achieved relatively easily (see col.8, lines 65-67, col. 12, lines 60-67, col. 13, lines 60-67, and col. 15, lines 39-48 of *Crozier et al.*).

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According to *Crozier et al.*, this method of designing a magnet can achieve a relatively short magnet design which has the following characteristics, a length shorter than 1.2 m, an image volume as large as 45 x 103 cm^3, a homogeneity of 20 ppm or less, a short 5G fringe field of 3m x 2.5m, etc. With this design method of *Crozier et al.*, the primary coils can include automatically negative current coils, and the shielding coils can be split into more than two coils or even with coils carrying opposite currents (see Claims 1-17 of *Crozier et al.*).

Furthermore, according to *Crozier et al.*, when using this method to design a shim magnet, the shim coils can be designed to have high purity in the harmonics, which is demonstrated by the ratio of 1000 or more between the magnitude of the desired harmonic and the sum of the magnitude of neighboring harmonics (see col. 5, lines 15-18, col. 9, lines 1-12, and col. 14, lines 50-61).

However, *Crozier et al.* describes the method using the simulated annealing procedure to minimize the error function for designing an MRI magnet, a shim magnet, or a gradient magnet separately. There is no disclosure or suggestion of Applicants' process in which the correction coil(s) are used in the design of

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the magnet coil design and considered together with the magnet coils in order to reduce the lower order harmonics of the entire system (magnet coils plus the correction coils). Thus, in contrast to Applicants' process, *Crozier et al.* cannot avoid excessive iterations of design cycles and more costly output results that have more coil turns and/or more number of coils with positively or negative currents.

Crozier et al. mentions that the lower order harmonics left in the magnet design may be compensated for in the shimming process or in further optimization runs (see, e.g., col. 10, lines 50-59, and col. 14, lines 12-18). The annealing design process and the shimming process are two separate processes in *Crozier et al.* In *Crozier et al.'s* design process, the harmonics are not minimized or utilize a correction coil or a set of correction coils. Thus, *Crozier et al.'s* process is different from Applicants' process in which in one design process the harmonics will be minimized by both the magnet coils and the correction coil, which make the design process simple and more efficient, and shortens the design cycle.

The defects and deficiencies of the primary reference to *Crozier et al.* are nowhere remedied by the secondary reference to

Leue et al. *Leue et al.* discloses a gradient field switch for an MRI system, which is not a design for the MRI magnet itself. At col. 7, lines 11-14 of *Leue et al.*, a shimmed MRI system is mentioned that has homogeneity of 2 ppm in a volume of 5 cm. Again, this process is not a design process or method, but a readily shimmed MRI system for gradient applications that desire a good spatial linearity.

Accordingly, it is respectfully submitted that the claims are patentable over the cited references.

In view of the foregoing, it is respectfully requested that the claims be allowed and that this case be passed to issue.

Respectfully submitted,
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